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(54) Cryogenic air separation.

(57) A cryogenic air separation unit (10) comprises a number of compression stages (12, 14, 16) at least one of which is driven by two or more expander turbines (18, 20, 22) acting in parallel or series and linked for driving one or more compression stages (12) via a common or bull gear (34). One of said compression stages (12) may be linked directly to one of the expander turbines (18) via a gear (32, 36) which acts to form the output gear of the turbine and the input gear of the compressor.

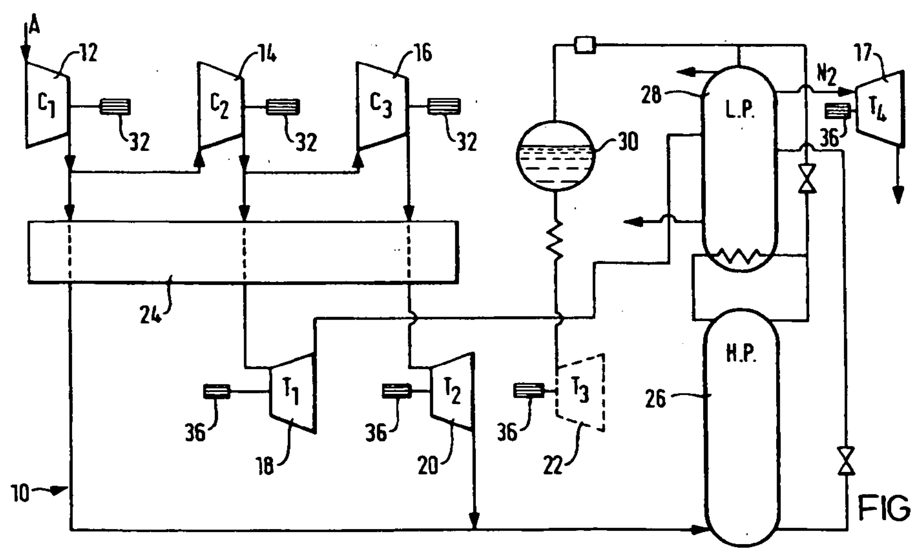

FIG.1

EP 0 672 877 A1

The present invention relates to cryogenic air separation and relates particularly, but not exclusively, to the operation of expander turbine driven compressors used in such a process.

A typical cryogenic air separation unit (ASU) comprises a number of compressors for compressing incoming air, a number of compressors for compressing nitrogen and a number of expander turbines used for expanding compressed air or nitrogen so as to lower the temperature and pressure thereof prior to its supply to one or other of the high pressure or low pressure distillation columns or heat exchangers. It is well known to use some of the energy released during gas expansion in the expander turbines to drive a compressor stage, however, in certain arrangements the power available from the expander turbine is insufficient to meet the requirements of the compressor. Additionally, in some arrangements, it is not possible to individually load each turbine. Also in some arrangements a small flow of nitrogen is required resulting in expensive standalone compressors

It is an object of the present invention to provide a cryogenic air separation apparatus which reduces and possibly eliminates both or one of the above mentioned problem.

Accordingly, the present invention provides a cryogenic air separation apparatus comprising two or more compression stages and two or more expander turbines in which said two or more expander turbines are linked in series or parallel to drive one or more compressor stages.

Preferably, said expander turbines are linked to said compressor via a common (bull) gear, each expander turbine having an output (driving) gear for driving said common gear and said one or more compressors having an input gear driven by said common (bull) gear.

Conveniently, said common (bull) gear comprises an externally toothed gear and said compressor input gear is driven from the same external teeth.

Advantageously, the apparatus further includes a motor for driving said common gear so as to drive said compressor as and when desired.

In a particularly useful arrangement, the apparatus further includes a generator driven from said common gear as and when desired. Also the apparatus may include a clutch or fluid coupling to disconnect the motor or generator when desired.

In certain process conditions the motor may act as a generator.

In certain circumstances, an expander turbine may be driven by gas expanded from a liquid state or by gas taken at pressure from a condenser column.

Conveniently, the liquid gas comprises liquid product or liquid by-product.

The present invention will now be more particularly described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of a cryogenic air separation unit incorporating features of the present invention, and

Figures 2, 3 and 4 illustrate three alternative arrangements of the present invention.

Referring briefly to Figure 1, a cryogenic air separation unit (ASU) 10 comprises a number of compression stages 12, 14, 16 for compressing incoming air A and a number of expander turbines 18, 20, 22 for expanding compressed air so as to reduce its temperature to that required in various stages of the cryogenic distillation process. Further components include a heat exchanger 24 and high and low pressure condenser columns 26, 28. The actual operation of the ASU forms no part of the present application and is therefore not described in detail herein, however, the following brief explanation is provided for the purpose of ensuring the readers understanding of Figure 1 attached hereto: Air is compressed in one or more compression stages 12 and part is passed through heat exchanger 24 and then direct to the high pressure column 26 so as to produce 'strip' nitrogen for the low pressure column. Surplus air is compressed by compression stage 14 and then split with part being directed to expansion turbine 18 for expansion and cooling therein prior to its introduction into the low pressure rectification column. Surplus air from compression stage 14 is directed to a compression stage 16, passed through heat exchanger 24 but removed part way therethrough and passed to expansion turbine 20 prior to being passed to the high pressure column where it supplements the airflow from compression stage 12. A supplementary turbine 22 driven by an expanded source of liquid product or by-product 30 may be provided for reasons which will be explained in detail late herein. Alternatively, a turbine 17 may be provided for expanding high pressure nitrogen directly from one or other of the two columns. The compressors 12, 14, 16 and turbines 18, 20, 22 are provided with respective driven and driving gears 32, 36 connected in a manner described below.

The operation of the present method of compressor driving is probably best illustrated by reference to Figures 2 to 4. In Figure 2, it will be seen that the driving gear 32 of one or other of the compressors 12, 14, 16 (hereinafter referred to as the compressor 12) is engaged for being driven by a bull or common gear 34. Two or more of the expander turbines 18, 20, 22 are connected for driving the bull gear 34 via driving gears 36. One or other of the output gears 36 may form the input gear 32 of the compressor 12. In the Figure 3 arrangement, the third expansion turbine 22 is ad-

ded to the driving force and connected for driving the bull gear 34 via output gear 36. A further additional feature is shown in Figure 4 and comprises an optional motor/generator combination 38, 40. Such components may be provided either separately or together and when provided together may be provided as individual units or combined together as one motor/generator combination and may include a clutch or fluid coupling 19 to disconnect the motor/generator

Operation of the present apparatus is simple with two or more turbines 18, 20, 22 driving bull gear 34 which in turn drives compressor 12 and/or compressor 14, 16, 17. The combined output from the turbines being sufficient to drive the compressor. Supplementary turbines 17 and 22 are added in the Figure 3 embodiment and acts to boost the driving force as and when desired by allowing expanded product or by-product gas to pass therethrough so as to drive the turbines 17, 22 and its associated driving gear 36 in a manner which facilitates the driving of bull gear 34. The provision of the motor/generator combination, shown in Figure 4, allows the motor to be used to boost the driving force of the turbines when the driving force is undesirably reduced, such as, for example when the ASU plant is turned down. When surplus energy is available, power may be generated by driving generator 40 directly form bull gear 34. As stated earlier, the bullgear may be connected to the motor generator 38, 40 by a clutch or fluid coupling which may be used to disconnect the motor generator when the expander power matches the compressor power and power balance is achieved.

Claims

1. A cryogenic air separation apparatus characterised by two or more compression stages (12, 14, 16) and two or more expander turbines (18, 20, 22) in which said two or more expander turbines (18, 20, 22) are linked in parallel or series to drive one or more compressor stages (18, 20, 22).

2. An apparatus as claimed in Claim 1 characterised in that said expander turbines (12, 14, 16) are linked to said compressor (12, 14, 16) via a common (bull) gear (34), each expander turbine (12, 14, 16) having an output (driving) gear (32) for driving said common gear (34) and said compressor or compressors (18, 20, 22) having an input gear (36) driven by said common (bull) gear (34).

3. An apparatus as claimed in Claim 1 or Claim 2 characterised in that said common gear (34) comprises an externally toothed gear and said compressor input gear (32) is driven from said external teeth.

4. An apparatus as claimed in any one of the preceding claims characterised by a motor (38) for driving said common gear (34) so as to drive said compressor (18, 20, 22) as and when desired.

5. An apparatus as claimed in any one of the preceding claims characterised by a generator (40) driven from said common gear (34) as and when desired.

6. An apparatus as claimed in any one of the preceding claims characterised by a clutch (19) or fluid coupling for disconnecting said motor (38) and or generator (40) from said common gear (34).

7. An apparatus as claimed in any one of Claims 1 to 6 in which an expander turbine (12, 14, 16) is driven by gas expanded from a liquid state.

8. An apparatus as claimed in Claim 7 characterised in that said liquid gas comprises liquid product or liquid by-product.

9. An apparatus as claimed in any one of the preceding claims characterised in that the output (driving) gear (32) of an expander turbine (12, 14, 16) forms the input gear (36) of said compressor (18, 20,22).

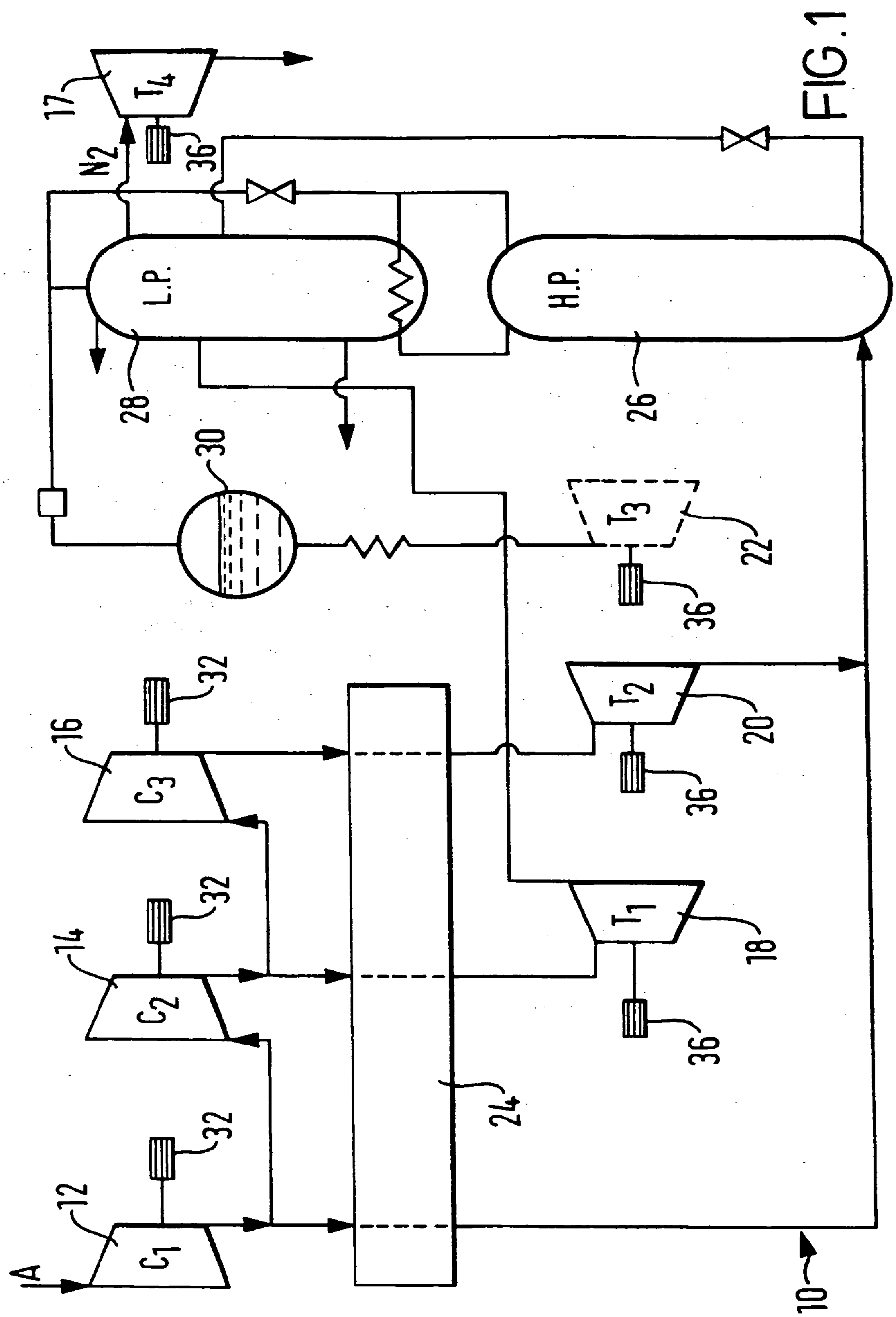

FIG.1

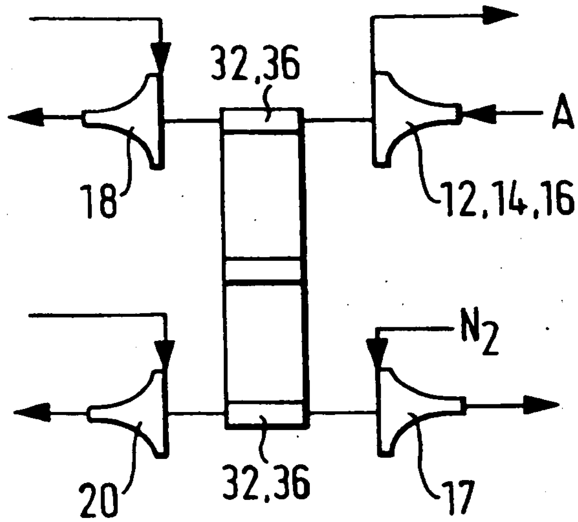

FIG. 2

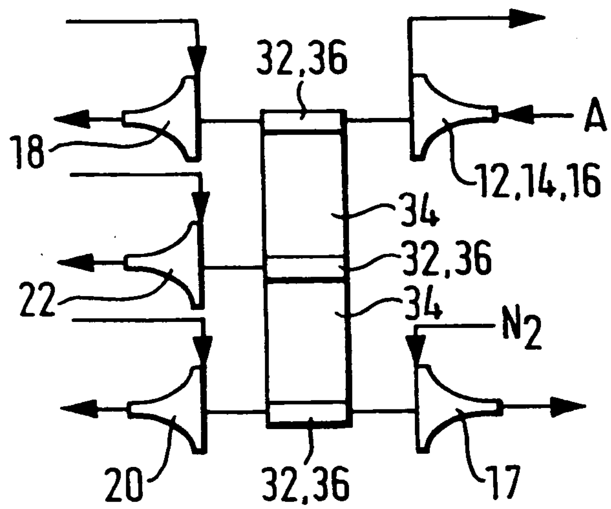

FIG. 3

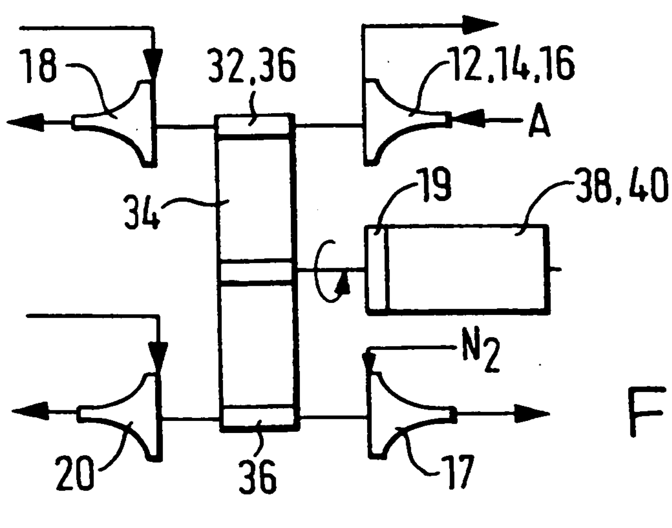

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 0488

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-3 477 239 (MESSER GRIESHEIM GMBH) * abstract * * column 1, line 29 - line 42 * * column 2, line 4 - line 40 * * column 3, line 1 - line 28 * * figure 2 * ---	1-4,6	F25J3/04 F01D15/12 F04D25/16
P,X	EP-A-0 592 803 (MAN GUTEHOFFNUNGSHÜTTE AG) 20 April 1994 * abstract * * claims 1,21 * * figure * -----	1,9	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F25J F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 June 1995	Siem, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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